

## REPORT DOCUMENTATION PAGE

AFRL-SR-BL-TR-02-

Public reporting burden for this collection of information is estimated to average 1 hour per response, including gathering and maintaining the data needed, and completing and reviewing the collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, One Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project 0704-0188.

sources,  
of this  
Jefferson

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE	3. REPORT TITLE AND DATES COVERED
		23JAN 02	FINAL (01 APR 00 TO 31 MAR 01)
4. TITLE AND SUBTITLE		5. FUNDING NUMBERS	
AN ANECHOIC AEROACOUSTIC TEST FACILITY		F49620-00-1-0235	
6. AUTHOR(S)		8. PERFORMING ORGANIZATION REPORT NUMBER	
LOUIS N. CATTAFESTA			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)		9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	
UNIVERSITY OF FLORIDA DEPARTMENT OF AEROSPACE ENGINEERING P.O. 116250 231 AWROSPACE BUILDING CAINESVILLE FL 32611-6250		AIR FORCE OFFICE OF SCIENTIFIC RESEARCH 801 N. RANDOLPH STREET ARLINGTON, VA 22203	
10. SPONSORING/MONITORING AGENCY REPORT NUMBER		11. SUPPLEMENTARY NOTES	
		AIR FORCE OFFICE OF SCIENTIFIC RESEARCH (AFOSR)	
12a. DISTRIBUTION AVAILABILITY STATEMENT		12b. DISTRIBUTION CODE	
Approved for public release; distribution unlimited.		NOTICE OF TRANSMITTAL DTIC, 12b. DISTRIBUTION CODE HAS BEEN REVIEWED AND IS APPROVED FOR PUBLIC RELEASE LAW AFR 190-12. DISTRIBUTION IS UNLIMITED.	
13. ABSTRACT (Maximum 200 words)			
The university of Florida has completed the construction of an advanced aeroacoustics testbed to facilitate both existing and future Air Force/DOD research projects. The proposed facility consists of a versatile anechoic chamber processing a test volume of 18'0" L x 16' 6" W x 7' 8" H and a low-frequency cutoff of 100Hz. The facility leverages a recently completed high-pressure air facility to provide supersonic (and subsonic) jet flows. In addition, the chamber has removable floor wedges to provide either anechoic or semi-anechoic test environments. The facility is equipped with a 5 DOF traverse to allow a myriad of detailed flow, noise, and vibration measurements. In particular, the experimental capabilities of this facility include flow measurements via PIV, LDV, and hot-wire anemometry, automated sound-intensity mapping and source localization capabilities via beam forming arrays, and complete surface vibration characterization vibrometry.			
The facility provides a unique capability to study fundamental aeroacoustic problems and structure-borne noise phenomena. The uniqueness stems from the combination of a low cutoff frequency (100 Hz), large chamber size, a high-speed flow capability, the ability to switch between a semi-and fully-anechoic chamber, and advanced instrumentation flow, acoustic, and vibration measurements. Most existing anechoic chambers, particularly the few available at universities, have only some of these features, thereby limiting their utility.			
14. SUBJECT TERMS		20020221 060	
		15. NUMBER OF PAGES 10	
		16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	

JAN 24 2002



UNIVERSITY OF  
**FLORIDA**

---

**FAX COVERSHEET**

DATE: January 23, 2002

TO: Wendy Veon

AFFILIATION: Air Force Office of Scientific Research

FAX NUMBER: 703-696-9733

FROM: Jan Machnik

NUMBER OF PAGES (INCLUDING COVER): 11

MAIL COPY TO FOLLOW: YES  NO

SPECIAL INSTRUCTIONS:

In response to the delinquent awardee list, I am faxing a copy of the final report submitted by Dr. Louis Cattafesta for #F49620-00-1-0235.

If there are any questions, please feel free to contact me. (e-mail: [jcm@aero.ufl.edu](mailto:jcm@aero.ufl.edu) or the phone number below)

---

IF YOU DO NOT RECEIVE ALL PAGES, PLEASE CALL ASAP.

DEPARTMENT OF AEROSPACE ENGINEERING,  
MECHANICS & ENGINEERING SCIENCE  
UNIVERSITY OF FLORIDA  
POB 116250  
231 AEROSPACE BUILDING  
GAINESVILLE FL 32611-6250

PHONE: (352) 392-0961  
SUNCOM: 622-0961

FAX: (352) 392-7303

**FINAL REPORT: AN ANECHOIC AEROACOUSTIC TEST FACILITY**

F49620-00-1-0235

**Louis N. Cattafesta III, Paul Hubner, Mark Sheplak, and Bruce Carroll**

University of Florida

November 1, 2001

**Summary**

The University of Florida has completed the construction of an advanced aeroacoustics testbed to facilitate both existing and future Air Force/DOD research projects. The proposed facility consists of a versatile anechoic chamber (Figure 1) possessing a test volume of 18' 0" L x 16' 6" W x 7' 8" H and a low-frequency cutoff of 100 Hz. The facility leverages a recently completed high-pressure air facility to provide supersonic (and subsonic) jet flows. In addition, the chamber has removable floor wedges to provide either anechoic or semi-anechoic test environments. The facility is equipped with a 5 DOF traverse to allow a myriad of detailed flow, noise, and vibration measurements. In particular, the experimental capabilities of this facility include flow measurements via PIV, LDV, and hot-wire anemometry, automated sound-intensity mapping and source localization capabilities via beamforming arrays, and complete surface vibration characterization via scanning laser vibrometry.

The facility provides a unique capability to study fundamental aeroacoustic problems and structure-borne noise phenomena. The uniqueness stems from the combination of a low cutoff frequency (100 Hz), large chamber size, a high-speed flow capability, the ability to switch between a semi- and fully-anechoic chamber, and advanced instrumentation for flow, acoustic, and vibration measurements. Most existing anechoic chambers, particularly the few available at universities, have only some of these features, thereby limiting their utility.

Pertinent applications of the facility include aeroacoustics, structural acoustics, and industrial noise/vibration control. Aeroacoustic applications include jet noise and mixing, self-sustaining flow oscillations, fluid-structure interactions (e.g., flutter), and noise from, for example, rotating machinery. Potential structural acoustic applications include control of

radiated noise from vibrating structures and vibration control. Finally, industrial noise and vibration control studies of large machinery can be conducted in the facility. This report summarizes the completed and ongoing tasks and provides a detailed description of the facility and associated instrumentation.

Completed Tasks:

- Construction of the anechoic chamber facility
- Acquisition of test process, control and measurement instrumentation
- Installation of the microphone traversing and data acquisition system
- Installation of the jet flow reservoir, control valves, and process flow instrumentation

Current Tasks:

- Validation of anechoic chamber 100 Hz cut-off frequency performance
- Validation of jet-flow process control equipment and operation
- Validation and calibration of flow entrainment during jet-flow operation
- Modification to traversing system telescope
- Documentation of all operation and safety procedures

**General Description**

The Aeroacoustic Anechoic Chamber at the University of Florida's Department of Aerospace Engineering, Mechanics, and Engineering Science is the newest addition to its experimental research facilities. A top-view schematic of the facility is shown in Figure 1. The chamber, custom-designed and fabricated by Eckel Industries, is currently in a validation and calibration stage of operation. The inner dimensions (wedge tip to wedge tip) of the modular acoustic chamber are approximately 18 ft long by 16 ft 6 in wide by 10 ft 10 in high without floor wedge installation and 7 ft 8 in high with floor wedge installation. Figures 2 through 5 show the four interior walls with wedge treatment installed. The wedges are designed with a low-frequency cut-off of 100 Hz and are constructed from fiberglass with cloth covers to protect

the wedge integrity. The anechoic zone (or area) at this frequency is 10 ft 10 in by 12 ft 4 in. A less stringent cut-off frequency affords a larger measurement area. The floor wedges are removable, allowing the facility to be run in either a full- or hemi-anechoic mode.

The chamber is designed to be utilized as either an aeroacoustic jet-flow facility or a more traditional calibration or industrial-equipment test facility. An intake and exhaust plenums (Figure 6) bound the south and north chamber walls, respectively, to properly handle entrained flow when run as an aeroacoustic facility. The plenums have built-in silencers to suppress outside noise transmission and perforated, insulated walls to suppress inside noise reflection. The wedges along the concurrent plenum/chamber walls have openings to allow entrained flow to pass through the chamber. The intake plenum houses the reservoir which is plumbed into the department's compressor facility. The dual-screw compressor (rated for 1000 SCFM at 210 psi) can continuously feed a perfectly expanded 1 in diameter Mach 2 jet. With 1200 cubic ft of storage tank capacity, larger nozzles or ducts can be tested in a blowdown manner. The nozzles connect to the reservoir via 6 in diameter pipe. The large diameter minimizes pressure loss and assures a large reservoir area to exit area ratios. Within the 6 in pipe and upstream of the nozzle, flow conditioning honeycomb and screens can be installed. Opposite of the nozzle is a large bell-mouth and muffler assembly to capture and exhaust the jet. Figure 7 shows an exterior view of the exhaust plenum, flow silencers, and control fan.

Outfitted on the ceiling of the chamber is a fully-automated, five component B&K microphone positioning system. It is integrate via software with B&K Pulse measurement and analysis system. Ambient chamber pressure and temperature are continually monitored on a separate data acquisition system. Specific characteristics of both systems are listed in the following section. The chamber has both 6 ft- and 3 ft-wide access doors as well as cable portals for instrumentation installed inside the facility.

**Facility Specifications:****Chamber**

Manufacturer: Eckel Industries  
Interior Size (wedge tip to wedge tip): 18' 0" L x 16' 6" W x 7' 8" H  
Frequency Cut-off: 100 Hz  
Wedge Material: Fiberglass with cloth cover

***Additional Features***

- Cold jet flow accommodations
- Five DOF traverse system
- Floor wedges on castors and designed with protect grates
- Perforated endwalls with ventilating wedges for jet flow entrainment
- Intake, exhaust, and A/C silencers
- Bell mouth and jet flow silencer
- Variable speed exhaust fan
- Instrumentation sleeves
- Single and double door access

**Instrumentation:**

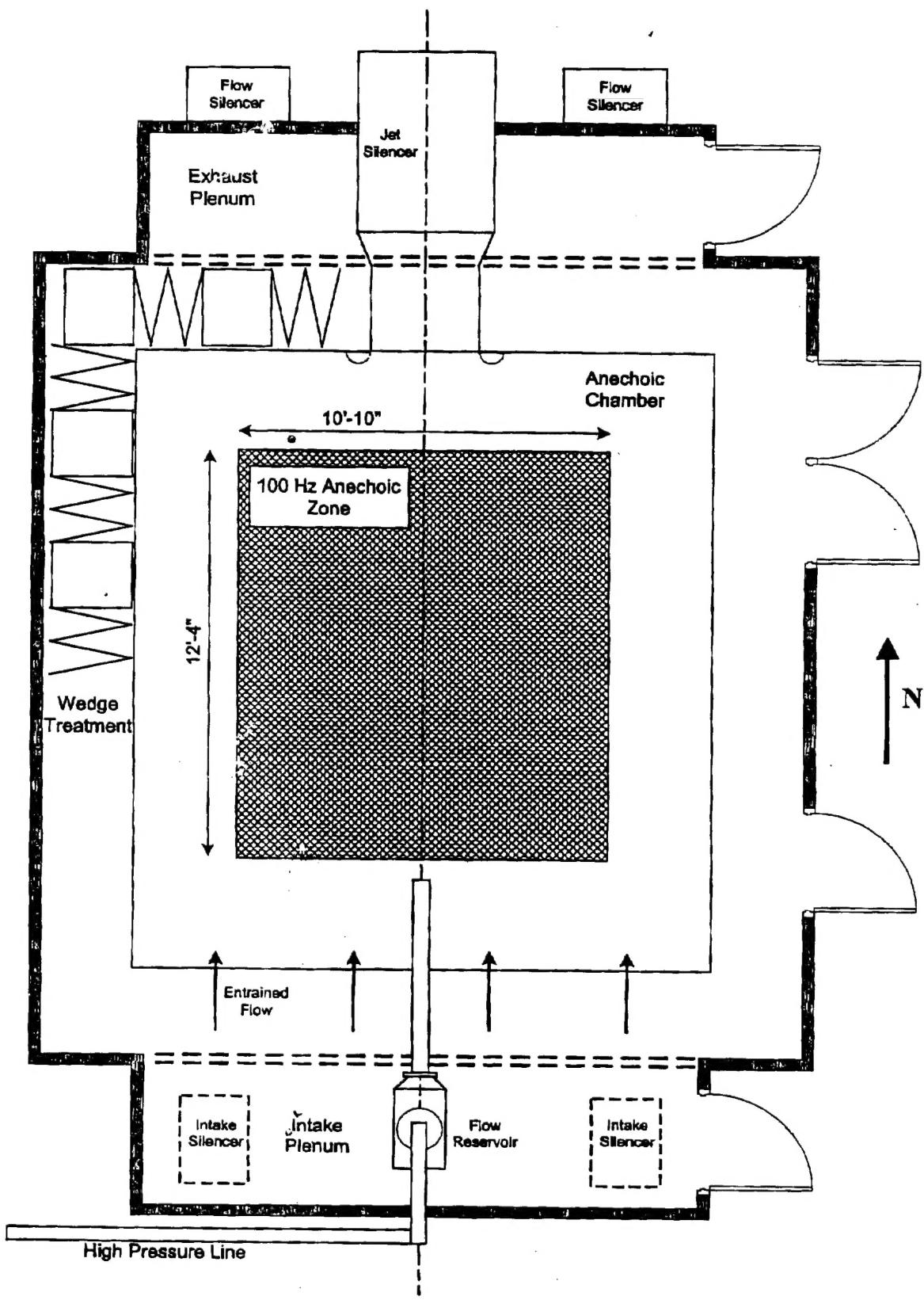
- B&K microphone and pulse analyzer system
  - Six  $\frac{1}{4}$  in free-field microphones and preamplifiers
  - Six 1/8 in pressure field microphones and preamplifiers
  - Eight channel portable PULSE (data acquisition and analysis) system
  - PC controlled
- B&K positioning system
  - Five degrees of freedom: 3 translation and 2 rotation
  - PC controlled
- Heise two channel pressure measurement system
  - Channel 1 0-30 psi absolute
  - Channel 2 0-300 psi absolute
  - PC controlled
- National Instruments data acquisition and signal conditioning system
  - Eight channel differential analog input
  - Two channel analog output
  - 16 channel multiplexer/signal conditioner
  - PC controlled

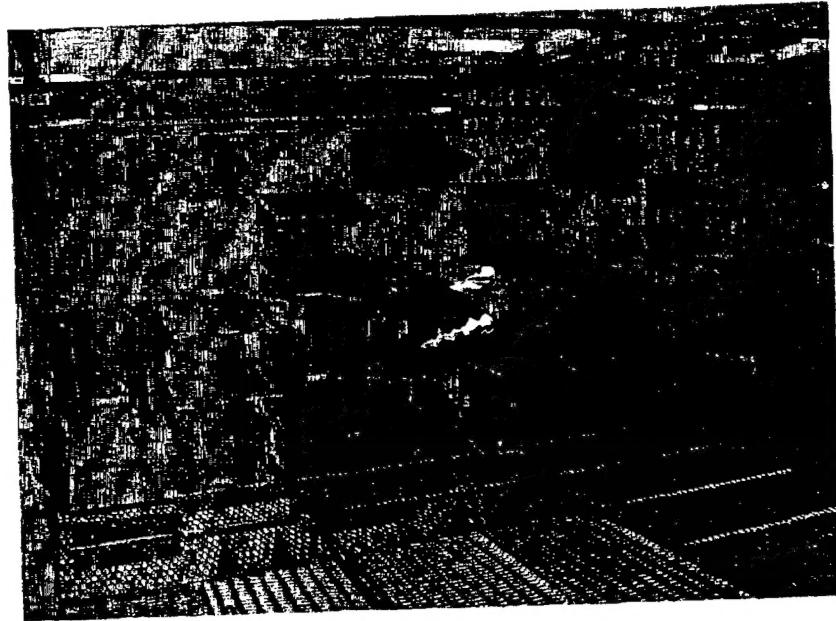
**Jet Flow Accommodations**

The anechoic chamber has been designed to integrate a cold jet flow for fundamental aeroacoustic testing. A reservoir chamber, residing in the intake plenum, has been plumbed into the existing dual-screw compressor facility. A dedicated PC system is used to monitor and control system process parameters. These include flow rate, stagnation and ambient pressure and temperature, and entrained flow rate.

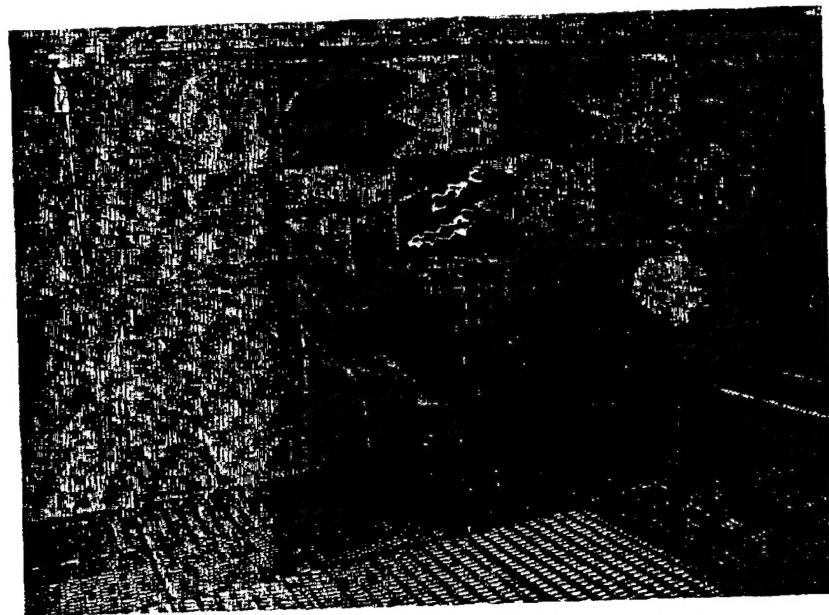
- Compressor facility
  - 210 psig maximum operating pressure
  - 900 SCFM flow capacity
  - 1200 ft<sup>3</sup> storage capacity
- Nominal jet flow design for continuous operation
  - Mach 2 perfectly expanded at ambient conditions
  - 1 in diameter nozzle

Figure 1. Top view schematic of the anechoic chamber.

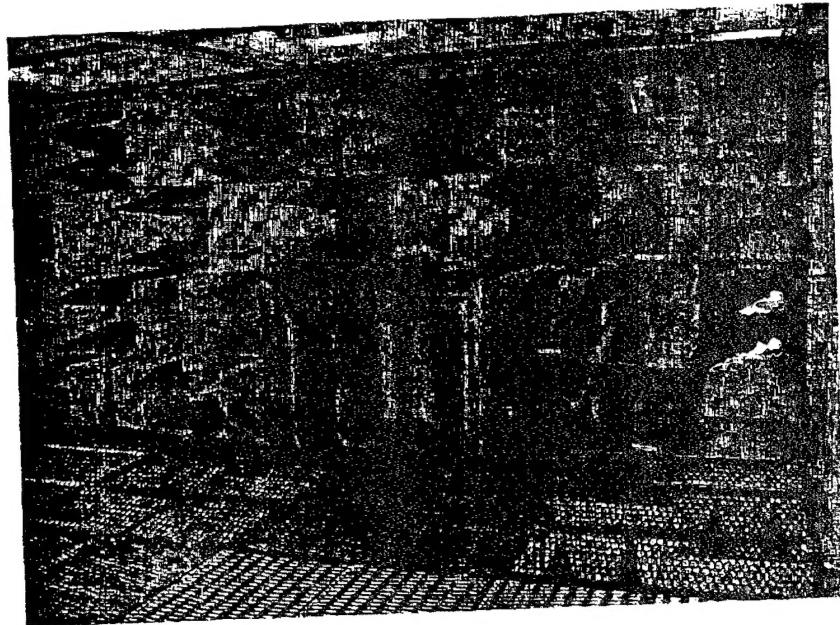




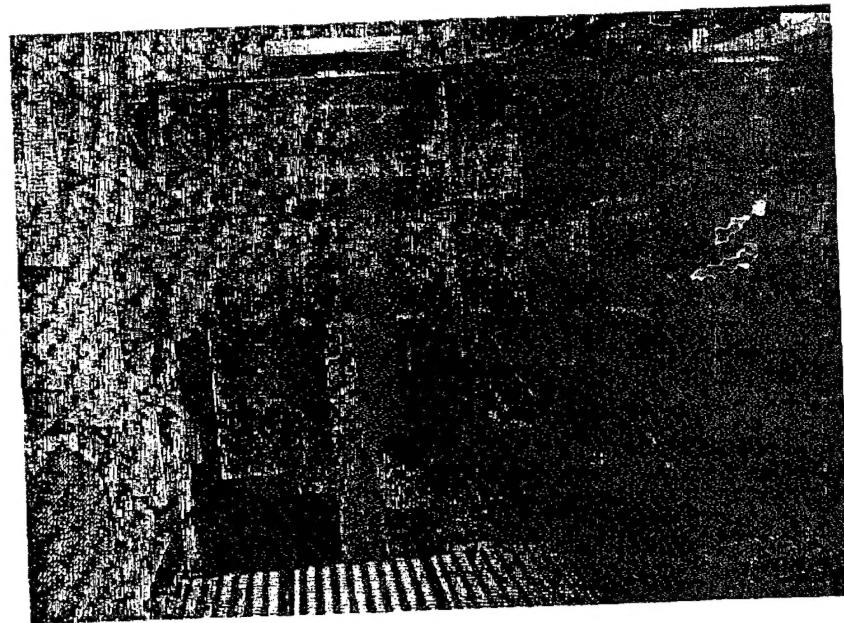
**Figure 2.** Interior South Wall with ventilation wedges. Floor wedges protected by expanded metal grates. Traverse system mounted to ceiling.



**Figure 3.** Interior West Wall.



**Figure 4.** Interior North Wall with ventilation wedge and jet bell-mouth.



**Figure 5.** Interior East Wall. One-side of double door open with wedge plug removed.

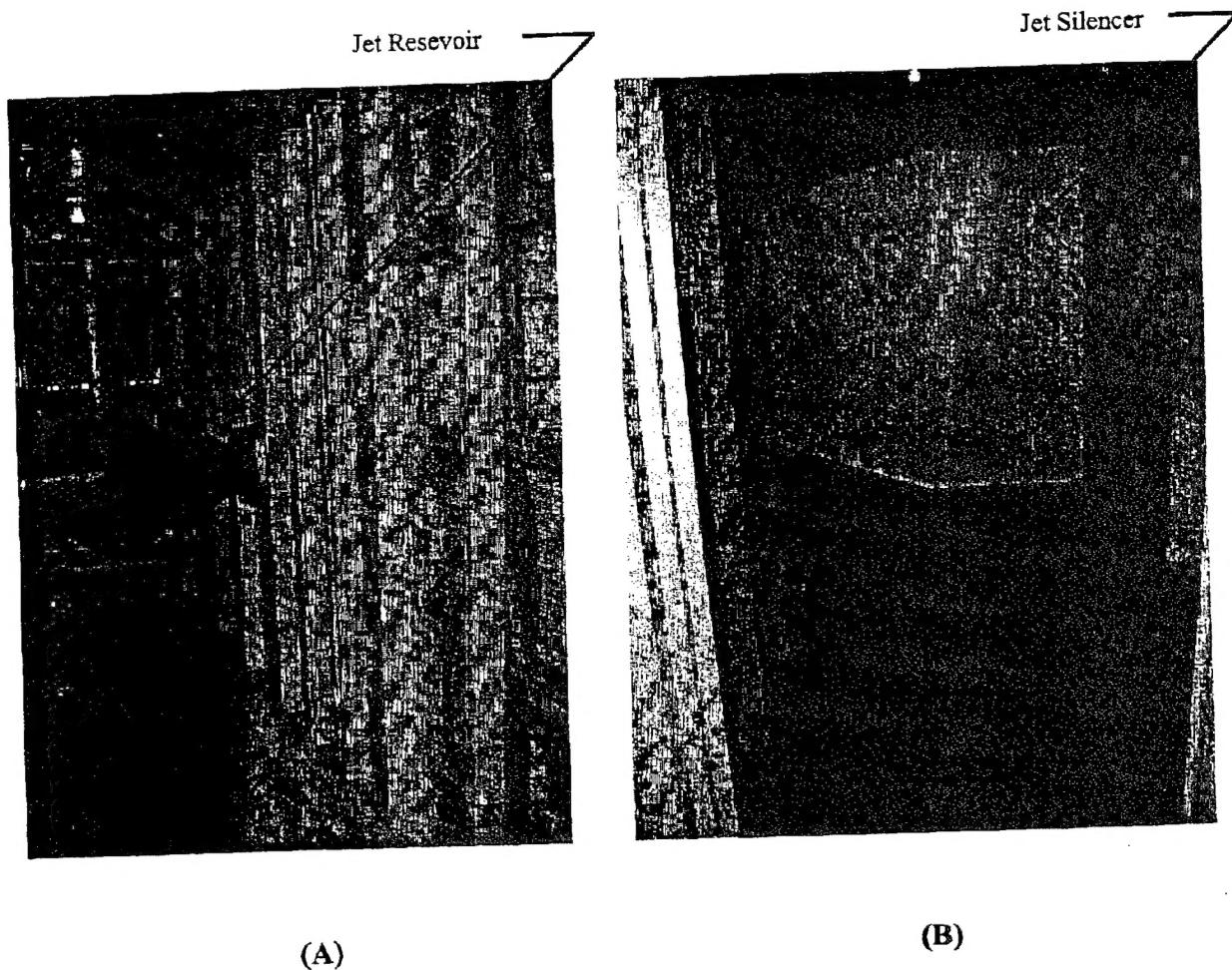


Figure 6. The intake plenum (A) and exhaust plenum (B).

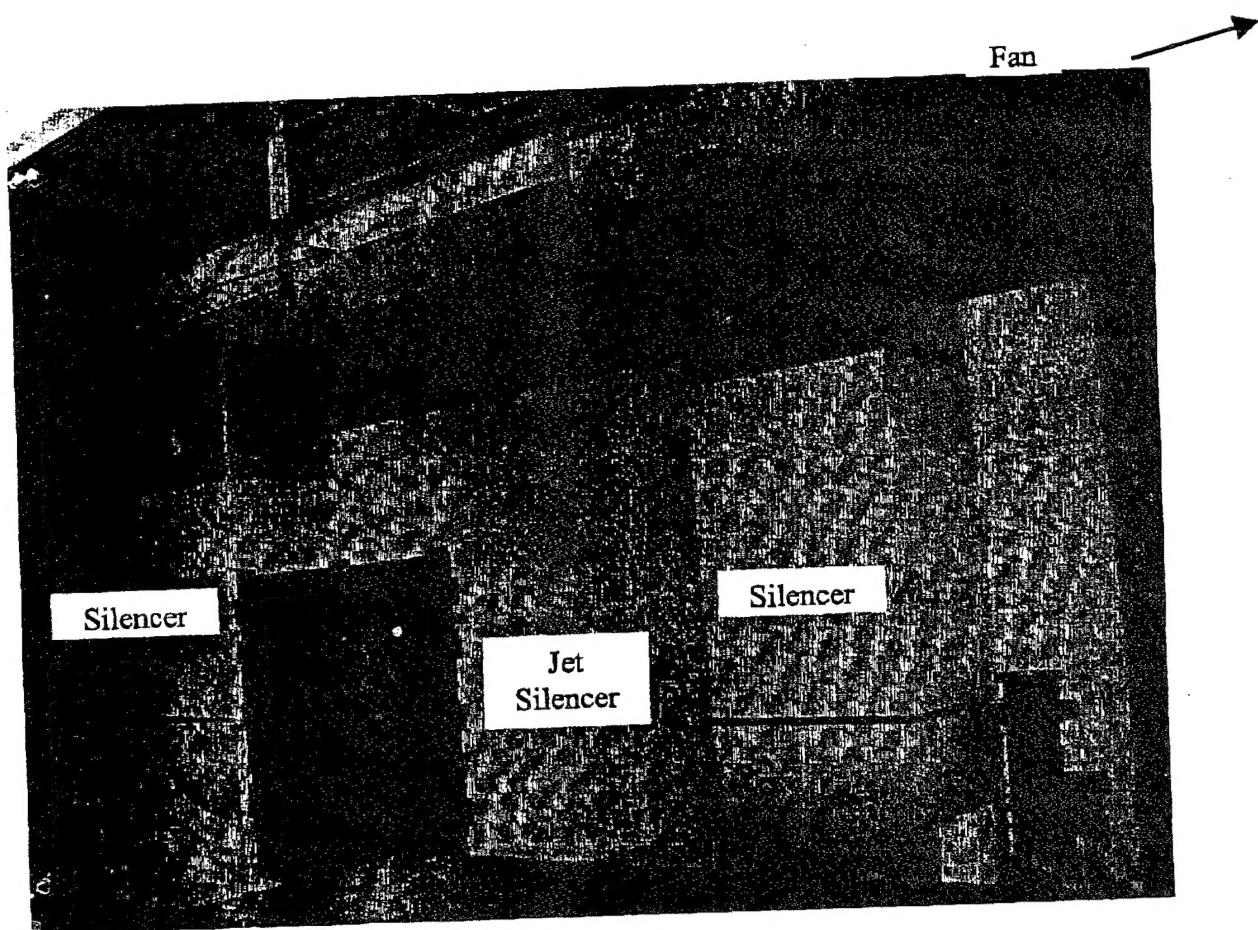


Figure 7. Outside view of chamber and its exhaust handing ductwork.